

## Memorandum

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To: J. MIKE LEONARDO  
Acting Chief Engineer

Date: July 7, 2004

From: MARK LEJA  
Chief  
Division of Design



Subject: Review of Departmental Policy on Metrication

In 1993, the Department adopted the International System of Units (SI; a.k.a. the Metric System) as our preferred system of weights and measures to comply with federal law. The law was subsequently changed to allow metric to be optional. There are ongoing additional costs associated with using the metric system. A team was recently formed to re-evaluate Caltrans' metric policy and make a recommendation regarding the continued use of metric units. Attached is a decision document and recommendation from the team, which I support and request your concurrence.

The team identified five alternatives ranging from a continuation of the current all-metric policy (Alternative 1, No Change) to middle ground alternatives using dual units, and finally, to reverting completely back to the English system of units (Alternative 5). Alternative 5 is recommended because it will align the Department with the practices and procedures used by the Department's primary customers: the contracting industry, the Local Agencies in California, and the citizens we serve. In addition, there are long-term financial advantages to the Department after an initial investment of resources.

The fiscal resources needed over a four-year period for the Department to revert back to using English Units and Standards are estimated to be 57 PYs, with a total cost of approximately \$9.0 million. An approximation of the annual savings is \$35 million to \$40 million beginning in the fourth year of the recommended four-year transition period and is expected to come primarily from reduced contract bid prices.

It will be necessary to establish a Project Manager to support a Management Advisory Committee and lead a Transition Team.

It is estimated that a transition period of two years will be needed to convert all departmental manuals, guidance, and standards documents to English Units. Concurrently, a transition period of three to four years should be anticipated to convert or deliver projects currently in the project delivery process.

Attachments

**DECISION DOCUMENT**  
**REVIEW OF DEPARTMENTAL POLICY ON METRICATION**  
**[Director's Policy 15 and Deputy Directive 12]**

**April 26, 2004**

**ISSUE**

In 1993, the Department adopted the International System of Units (SI; a.k.a. the Metric System) as our preferred system of weights and measures to comply with federal law. The law was subsequently changed to allow metric to be optional. There are ongoing additional costs associated with using the Metric System. Should the Department continue to use the Metric System as its preferred system of weights and measures?

**BACKGROUND**

Department Director's Policy 15, and Deputy Directive 12, both entitled Metrication [see Attachments A and B], were adopted to comply with federal law (1988 Omnibus Trade and Competitiveness Act) and the Federal Highway Administration's (FHWA) Metric Conversion Plan (approved October 31, 1991) that required metric conversion activities begin in Fiscal Year 1992 and be completed by October 1996.

The FHWA Metric Conversion Plan mandated that the Department convert all manuals, publications, and standards to the SI, and all federally funded construction projects advertised after September 30, 1996, be designed utilizing SI. The result was that the Department was required to convert to SI or be subjected to the loss of federal funds.

In 1995, the National Highway System Designation Act contained language that postponed the federal metric mandate and was signed into law by the President. However, by this time, the Department had made great progress and spent many resources toward completing the metric conversion effort and made a business decision to continue to meet the federal metric mandate of September 30, 1996. The Department did successfully meet the requirements of the FHWA Metrication Plan, even though the threat of losing federal funding was lifted.

In 1999, the Department's Metric Policy was changed to allow the use of dual units (English and Metric) on encroachment permit projects. Dual unit encroachment permit projects no longer required an exception.

In 2001, the FHWA changed its policy on the use of SI in documents prepared by state departments of transportation (SDOTs) for federal-aid highway projects. The use of SI in documents prepared by the SDOTs was made optional. However, the FHWA did not change its policy on the use of SI in documents prepared by that organization. The FHWA continues to use SI in their daily business activities.

# **DECISION DOCUMENT**

## **REVIEW OF DEPARTMENTAL POLICY ON METRICATION**

**[Director's Policy 15 and Deputy Directive 12]**

**April 26, 2004**

In 2002, the Department published a dual unit version of the Standard Specifications, Standard Plans, and Standard Special Provisions for use by the local agencies on projects off the State Highway system. However, the Departmental Metric Policy was reaffirmed and all manuals, standards, specifications, plans and other documents developed for use on the State Highway system still were required to use SI, with some exceptions [see Attachment C].

In July 2003, the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Design conducted a survey of the SDOTs on the system of units used for the design, and ultimately, the construction of projects in their state [Attachment D]. As a result of the AASHTO survey and other feedback the Department has received from our transportation customers and partners, a multi-functional Departmental Team was formed to review the two Departmental Policies on Metrication (Director's Policy 15 and Deputy Directive 12); plus, gather information and data related to the various viable alternatives, so that a Department-wide decision can be made. The team members were delegates from several divisions: Design (Kevin Herritt); Construction (Gene Mallette); Engineering Services (Brian Lee, Don Scheed); Traffic Operation (Gerry Meis); Local Assistance (Kevin Pokrajac and Frank Cao); and Right of Way (Mark Turner). Other divisions, which have less impact by the proposed changes, were contacted by team members.

### **ALTERNATIVES DISCUSSED BY THE TEAM**

1. Continue current departmental practice (Metric System) –  
*Metric System preferred with exceptions*
2. Metric System-with Dual Unit contract support documents –  
*Metric System preferred with exceptions; Dual Unit Standard Plans, Specifications, & Special Provisions documents supported with identified departmental resources to continuously maintain, and publish them periodically.*
3. Change departmental policy to preferring the use of Dual Units, with the Metric Units being the Department standards - all departmental publications and daily business practices.
4. Change departmental policy to preferring the use of Dual Units, with the U.S. Customary System of Weights and Measures (English Units) being the Department standards - all departmental publications and daily business practices.
5. Rescind the departmental policies preferring the use of the Metric System and transition back to using English Units and Standards - all departmental publications and daily business practices.

# **DECISION DOCUMENT**

## **REVIEW OF DEPARTMENTAL POLICY ON METRICATION**

[Director's Policy 15 and Deputy Directive 12]

April 26, 2004

### **DISCUSSION**

#### **ALTERNATIVE 1 – Metric System**

This Alternative proposes to continue the current practice of the Department. The Department would continue the use of the Metric System. Exceptions would be granted as currently defined in Attachment C. The Department would not support with resources the maintenance and further development of the Dual Unit Standard Plans, Specifications, and Special Provisions. These contract documents are used primarily by local agencies and are not allowed on Department administered contracts.

The Team used this alternative as the basis for a comparison of departmental transition costs back to using English Units and Standards, Alternative 5 [see Attachment F].

#### **Pros**

- No changes required to current departmental business practices.
- Department designers are trained and efficient in using Metric Units and Standards.
- No additional resources required or needed to be redirected at the expense of other workload.
- Project delivery will not be affected.

#### **Cons**

- The Department will continue to pay an estimated \$38 million per year in additional costs. This estimate is based on a recent survey of contractors that bid on Department projects, which indicated an average additional cost per contract of 1.8%.
- Working in Metric Units inhibits communication because nearly all of our transportation partners, and the citizens of California, work with and communicate in English Units in their daily activities.
- Local Agencies have requested preparation and maintenance of Dual Unit Standard Plans, Specifications and Special Provisions for their use on local project contracts. These documents will not be provided by the Department.
- Requires some duplicate work when working with the public, utility companies, and railroads.
- Court trials require documents and exhibits in English Units.
- Survey work and mapping takes longer because of the continual need to convert between Metric Units and English Units and vise-versa.
- Not supported by the AB 1012 Project Delivery Team recommendations.
- Not supported by the results of a recent survey of members of the Consultant Engineers and Land Surveyors of California (CELSOC).
- Not supported by Local Agency Survey.

# **DECISION DOCUMENT**

## **REVIEW OF DEPARTMENTAL POLICY ON METRICATION**

[Director's Policy 15 and Deputy Directive 12]

**April 26, 2004**

### **ALTERNATIVE 2 – Metric System (with Dual Unit Standard Plans, Specifications, and Special Provisions)**

This Alternative proposes to recommit the Department to the previously agreed upon decision to continue the preferred use of Metric Units and use them predominately in our daily business and contract documents, as described in Alternative 1. In addition, the Department will commit to providing, to the appropriate divisions performing the additional work, the additional resources required to support the maintenance and further development of the Dual Unit Standard Plans, Specifications, and Special Provisions exclusively for the use by our Local Agency partners.

#### **Pros**

- Local Agencies, if they choose, will be able to adopt and/or use Department developed Dual Unit Standard Plans and Specifications for their own projects.
- The FHWA)Manual of Uniform Traffic Control Devices (MUTCD) is published using dual units.
- Resources spent to modify the Metric Standard Plans, Specifications, and Special Provisions into their complimentary dual unit versions will not be wasted.

#### **Cons**

- Department employees that are responsible for the Standard Plans, Specifications, and Special Provisions will be required to do additional work.
- Maintaining two versions of the Standard Plans, Specifications, and Special Provisions will require additional resources above the current level to maintain in the future.
- The Department will continue to be inconsistent in its use of weights and measures while performing its daily business.
- Not supported by the AB 1012 Project Delivery Team recommendations.
- Policy is not supported by CELSOC survey.
- Policy is not supported by Local Agency Survey.

### **ALTERNATIVE 3 – Change Departmental Policy to Dual Units (Metric Standards)**

This Alternative proposes to have the Department adopt a dual unit philosophy for standard books, manuals, and guidance, while performing our daily business in Metric Units. Some exceptions as to how daily business is performed across the Department may be needed to be granted, so that various divisions within the Department, can continue to produce and support manuals and guidance within their span of control in the system of weights and measures that best represent the needs of their primary customers.

# **DECISION DOCUMENT**

## **REVIEW OF DEPARTMENTAL POLICY ON METRICATION**

[Director's Policy 15 and Deputy Directive 12]

**April 26, 2004**

### **Pros**

- Local Agencies, if they choose, will be able to adopt and/or use Department Standard Plans and Specifications for their own projects.
- Provides the Department flexibility to conform to an unknown future national direction on the use of the Metric System.
- Allows the Department to continue to deliver projects in the "pipeline" in Metric Units and Standards.
- Allows the contractors to bid and build projects without additional costs due to conversions between systems of weights and measures.
- The Department will need to maintain and publish only one version of manuals and Standard Plans, Specifications, and Special Provisions.
- Provides consistency with the "Greenbook" (used as the official specification, bidding and contract document for many cities, counties and public agencies in Southern California) and the MUTCD.

### **Cons**

- Limited Department resources will be used to support both systems of weights and measure.
- Additional conversion costs and resources will be needed to develop English Standards.
- A combination of both systems of units on maps, plan sheets, and documents may cause difficulties reading and interpreting those items, and result in errors.
- Some divisions that never transitioned to using the Metric System will still likely not convert to a dual unit system.
- Still will have issues with vendors and suppliers, because Metric and English hardware are not interchangeable.
- Does not result in much tangible benefit and still perpetuates the use of the English Units that are typically better understood.
- Not supported by the AB 1012 Project Delivery Team recommendations.
- Policy is not supported by CELSOC survey.

### **ALTERNATIVE 4 - Change Departmental Policy to Dual Units (English Standards)**

This Alternative is the reverse of Alternative 3 and proposes to have the Department adopt a dual unit philosophy for standard books, manuals, and guidance, while performing our daily business using English Units and Standards. It is anticipated that the various divisions would not request exceptions to this policy, if it were to be adopted.

### **Pros**

- Local Agencies, if they choose, will be able to adopt and/or use Department Standard Plans and Specifications for their own projects.

# **DECISION DOCUMENT**

## **REVIEW OF DEPARTMENTAL POLICY ON METRICATION**

[Director's Policy 15 and Deputy Directive 12]

April 26, 2004

- Provides the Department flexibility to conform to an unknown future national direction on the use of the Metric System.
- Allows the Department to continue to deliver projects in the "pipeline" in Metric Units and Standards.
- Allows the contractors to bid and build projects without additional costs due to conversions between systems of weights and measure.
- The Department will need to maintain and publish only one version of manuals and Standard Plans, Specifications, and Special Provisions.

### **Cons**

- Limited Department resources will be used to support both systems of weights and measure.
- Additional conversion costs and resources will be needed to develop English and Metric Standards for minimal benefit, when compared to the development costs.
- A combination of both systems of units on maps, plan sheets, and documents may cause difficulties reading and interpreting those items, and result in errors.
- Still will have issues with vendors and suppliers, because Metric and English hardware are not interchangeable.
- English Unit databases that were never converted to the Metric System will still likely use English Units only.

### **ALTERNATIVE 5 –Transition Back to English Standards**

This Alternative proposes to rescind the departmental policies on Metrication and transition back to using English Units and Standards in the performance of the Department's daily business practices. The Team has evaluated this Alternative in detail and estimated the one-time departmental transition costs associated with this Alternative [see Attachment F]. The one-time transition cost is estimated to be approximately \$9.0 million over a four-year transition period. The four-year transition period is to be thought of as the worst-case scenario, as envisioned by this Team, and should be as short as reasonably possible.

### **Pros**

- The Department will save an estimated \$38 million per year in additional costs. This is based on an average 1.8% estimate per metric contract.
- Capital cost savings will be realized beginning in year three and will be able to be used to fund additional Capital Projects.
- Supports needs of the Department's primary customer of our PS&E packages – the contractor.
- Supports the desires of Local Agencies that choose to adopt and use the Department's Standard Plans and Specifications for their own projects.

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## **REVIEW OF DEPARTMENTAL POLICY ON METRICATION**

**[Director's Policy 15 and Deputy Directive 12]**

**April 26, 2004**

- Supported by CELSOC Survey.
- Supported by Local Agency Survey.
- Potential cost savings due to fewer miscommunications and errors between design intent and construction implementation, since conversions between systems of measure would no longer be performed.
- Eliminates duplicate work when working with the public, utility companies, and railroads.
- Using English scale maps as opposed to Metric scale maps will require 20% fewer Right of Way map sheets.
- English Units require less significant digits than Metric Units, so preparing mapping will be less time consuming.
- The Department will be consistent with nearly every one of our transportation partners (other state and federal agencies and departments; cities and counties; contracting industry; utility and railroad companies) and the citizens of California (developers, property owners, community residents) by using English Units.
- Department will be consistent with recommendations reported by the Transportation Project Delivery Advisory Teams created under AB 1012 (Torlakson 1999) on how transportation project delivery could be accelerated.

### **Cons**

- Using English Units will require 15% additional construction stakes (50-foot staking interval versus 20-meter staking interval) increasing support costs for projects requiring construction staking.
- May require a training effort once the English Standards are created and published.
- Project delivery may be impacted during the transition period.
- Project engineering and construction costs may both increase during the transition period, unless accommodations are made in the transition plan, as were made during the English to Metric conversion effort.
- Significant one-time resource expenditure to transition back to English Standards in departmental manuals, guidance, and other publications.
- Unknown future national policy on the use of the Metric System.
- Department credibility may be at risk because the Department is transitioning back to using English Units and Standards relatively quickly (within a 10-year time period).
- CADD as-built project files created in Metric Units will not be able to be used for base mapping without additional conversion efforts and costs.
- The design and drafting software used by the Department will need to be converted to allow the use of English Units.
- Department will be inconsistent with the National Geodetic Survey (NGS) and the U.S. Federal Geographic Data Committee (FGDC) surveying standards which are based on Metric Units.



**DECISION DOCUMENT**  
**REVIEW OF DEPARTMENTAL POLICY ON METRICATION**  
[Director's Policy 15 and Deputy Directive 12]  
**April 26, 2004**

**TEAM RECOMMENDATION**

Alternative 5 is recommended by the Team. This alternative is recommended because it will align the Department with the practices and procedures used by the Department's primary customers – the contracting industry, the local agencies in California, and the citizens we serve.

The Team, based upon departmental history recorded during the English to Metric Unit and Standards transition, estimates that a period of two years is a reasonable timeframe to convert all departmental manuals, guidance, and standards documents to English Units. Concurrently, a transition period of three to four years should be anticipated, for the projects that are currently in the project delivery process, to be phased out from predominately using the Metric System and 100% using English Units. The time period for transitioning projects from Metric Units to English Units should be as short as reasonably possible. These transition periods are subject to change depending upon the recommendations of the Departmental Management Advisory Committee and Transition Team.

**FISCAL IMPACT OF TEAM RECOMMENDATION**

The Team conducted a survey of the Department Divisions that will be the most effected by the transition from Metric to English Units, for an estimate of the transition costs related to Alternative 5. The Team also asked for feedback on the costs to the Divisions, if it were to be decided to continue to do daily business in Metric Units. The results of the surveys are captured and presented in Attachment F. The Team used \$80,000 per Personnel Year (PY) as the basis for converting a PY to a dollar amount.

The Division of Construction requested feedback from the construction industry related to their costs of continuing to do business in Metric Units [see Attachment E]. The costs of continuing business in Metric Units, or potential savings if the Department were to convert back to English Units, outweigh the departmental costs during the transition period and increase even more in favor of the recommended decision as time increases [see Attachment F].

In summary, it is estimated that the cost of converting back to English Units and Standards are approximately \$9.0 million distributed over a worst case scenario four-year transition period.

**ORGANIZATIONAL IMPACT OF TEAM RECOMMENDATION**

None.

# **DECISION DOCUMENT**

## **REVIEW OF DEPARTMENTAL POLICY ON METRICATION**

[Director's Policy 15 and Deputy Directive 12]

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### **DEPARTMENTAL RISKS ASSOCIATED WITH TEAM RECOMMENDATION**

1. **Future Project costs may be increased** to “bring up to standard” projects built using Metric Units and Standards.
2. **Public and Legislative** criticism for spending the resources needed to transition back to using English Units and Standards.
3. **Department credibility** because the Department is transitioning back to using English Units and Standards relatively quickly (within a 10-year time period).
4. Converting CAiCE software macros to English Units may cause **unforeseen complications and problems within the engineering software program.**
5. **The long-term national direction regarding the use of the Metric System is unknown.**

### **CONSIDERATIONS FOR TRANSITION TO ENGLISH**

#### **Transition Planning and Implementation:**

- It is recommended that a full-time **Project Manager** be designated to manage the transition from Metric to English Units and Standards in an effective and minimal period of time. A **Departmental Management Advisory Committee and Transition Team** should be established. The Project Manager will chair the Transition Team.
- A **Transition Plan** will need to be fully developed by the Transition Team with a defined product delivery schedule. The plan will need to address issues such as: updating/rescinding Department Policy documents and memoranda; converting manuals and other guidance documents to English Units and Standards; converting the Standard Plans, Specifications, and Special Provisions to English Units; determine the schedule and method for transitioning projects currently under development; how to handle projects that have been shelved due to the lack of available funding; and, coordination of the English transition with other ongoing Department activities (i.e., Style Guide for Specifications, Standard Plan and Specification Book update schedules, etc.). Attachment H has been developed to showcase the Team's ideas on what needs to be accomplished and in what sequence to effectively make this change become institutionalized.

# **DECISION DOCUMENT**

## **REVIEW OF DEPARTMENTAL POLICY ON METRICATION**

[Director's Policy 15 and Deputy Directive 12]

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### **Establish Exception Policy:**

- It will be necessary to establish criteria for exceptions to the English unit policy. For instance, large "international" projects may be developed and advertised in the Metric System to enhance competition. Major projects such as the San Francisco-Oakland Bay Bridge may benefit by having Metric weights and measures, if the Department waives "Buy America" requirements, and is seeking bids from International material suppliers.

### **Lessons Learned:**

- The Departmental Management Advisory Committee and Transition Team should capture **lessons learned from the other SDOTs** that have rescinded their adoption of the Metric System and have already reverted back to using English Units and Standards.
- The Departmental Management Advisory Committee and Transition Team should capture lessons learned from the Department's prior conversion from English to metric (for instance, **mapping lessons learned** from the English to Metric Conversion). The lesson learned is that if a project was mapped originally in one system of units, it should be delivered in that system of units – no matter what the timeframe is related to the transition schedule. During the English to Metric conversion effort, the Department had projects that: were half-built in one system of units and completed in the other system of units; and, required re-mapping or the existing photography to be recompiled into the new preferred system of units. All of these situations made it difficult to deliver projects on time and on budget. The lesson is that it was difficult for the Department to change project mapping in mid-stream. It was found to be much better if the projects "stayed the course" with the system of units in which they were initially mapped.

### **Resources and PY Allocation**

- **Resources and personnel** need to be provided and allocated to the units performing the actual transition work. Providing resources, without providing additional people, as has been done in the past two change efforts (English to Metric Units and the creation of the Dual Unit Standard Books) will impact other ongoing "Mission Critical" or prioritized departmental work.

### **Proposed Implementation Schedule**

- It is estimated that a transition period of two years will need to be provided to convert all departmental manuals, guidance, and standards documents to English Units. Concurrently, a transition period of three to four years should be anticipated to phase out the projects currently in the project delivery process.

# **DECISION DOCUMENT**

## **REVIEW OF DEPARTMENTAL POLICY ON METRICATION**

[Director's Policy 15 and Deputy Directive 12]

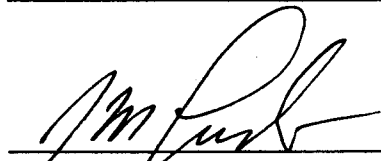
April 26, 2004

### **CONTACT PERSONS**

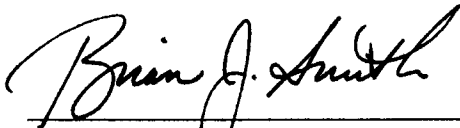
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### **APPROVAL RECOMMENDED**



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